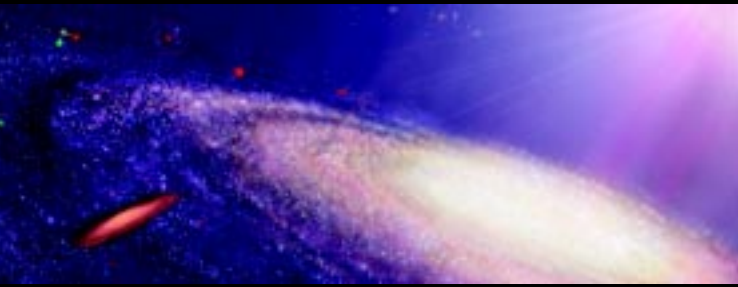


# ORIGINS



## We Seek

...to observe the birth of the earliest galaxies, the formation of stars, to find all the planetary systems in our solar neighborhood, to find planets that are capable of harboring life, and to learn whether life does exist beyond our solar system. We do this to understand the origins of our world. We do this to answer two questions:

Where did we come from?

Are we alone?

As our ancient forebears huddled around their campfires might have wondered—where they came from, what lies over the hill, what lurks outside the comforting light from their own fire—so we reach out now with our minds and our technology to understand where all that we see came from, and if we are unique and alone in the cosmos, or if we are one glint among many sparks of life. These questions are profound, yet are asked by nearly all, old and young, who lie on a beach or on a meadow and embrace in their vision the spectacle of the night sky.

We are privileged to live in a time marked by scientific and technological advances so rapid and so brilliant that these elusive and intriguing questions can be pursued not only with philosophical speculation but also with scientific observation. While the questions are simple, the scientific and technical capabilities needed to answer them are challenging. In this document, we present a scientific roadmap—with an emphasis on the first two

## N A S A ' S   V I S I O N

*To improve life here,  
To extend life to there,  
To find life beyond*



## N A S A ' S   M I S S I O N

*To understand and protect our home planet  
To explore the universe and search for life  
To inspire the next generation of explorers  
...as only NASA can*

decades of this century, followed by a vision for the far future—that will lead us to the answers that have intrigued but eluded humanity for millennia.

*Where did we come from?*

To answer this, we need to understand how today's universe of galaxies, stars and planets came to be, and how stars and planetary systems form and evolve.

*Are we alone?*

To answer this, we need to understand the building blocks of life, the conditions necessary for life to persist, and the signatures that it writes on the sky. We need to explore the diversity of other worlds and search for those that may harbor life.

## The Journey So Far

Eighty years ago, we didn't know that our galaxy wasn't the entire universe, that the fuzzy "nebulae" floating in the cosmos were really neighboring "island universes" like our own galaxy. Much has been learned in these few decades that gives us a vastly expanded sense of the universe and our place in it. Five years ago, we had not observed planets around other stars. Today, over one hundred planets and planetary systems have been detected using ground observatories. We are well into the age of discovery of our origins. It is now our challenge to map the roads to future exploration and gain an understanding of how galaxies, stars, planets...and life, came to be.

# ORIGINS



## About the Roadmap

This Roadmap is the product of deliberation and discussion by the Origins Subcommittee of NASA's Space Science Advisory Committee, working with representatives from NASA's field centers and with substantial input from the astronomical community. The Roadmap sets out a plan for a twenty-year period at the beginning of the millennium, with particular emphasis on activities advocated for new mission starts in the near-term (2005–2010) or mid-term (2010–2015) time frame.

The Subcommittee examined the broad scientific objectives discussed in this Roadmap, motivated by the two defining questions. For each objective, several research areas are defined to address multiple aspects of the objective. Within each research area, a number of specific investigations are called out and discussed in some technical detail. It is these investigations that give rise to the specific missions and tools that are required to make the necessary scientific observations. The Roadmap describes the Origins missions currently operating and in development, and focuses on those missions that will start in the near- and mid-term.



*The universe is enormous and  
ancient, but life—tiny and  
transient—is its precious jewel.*

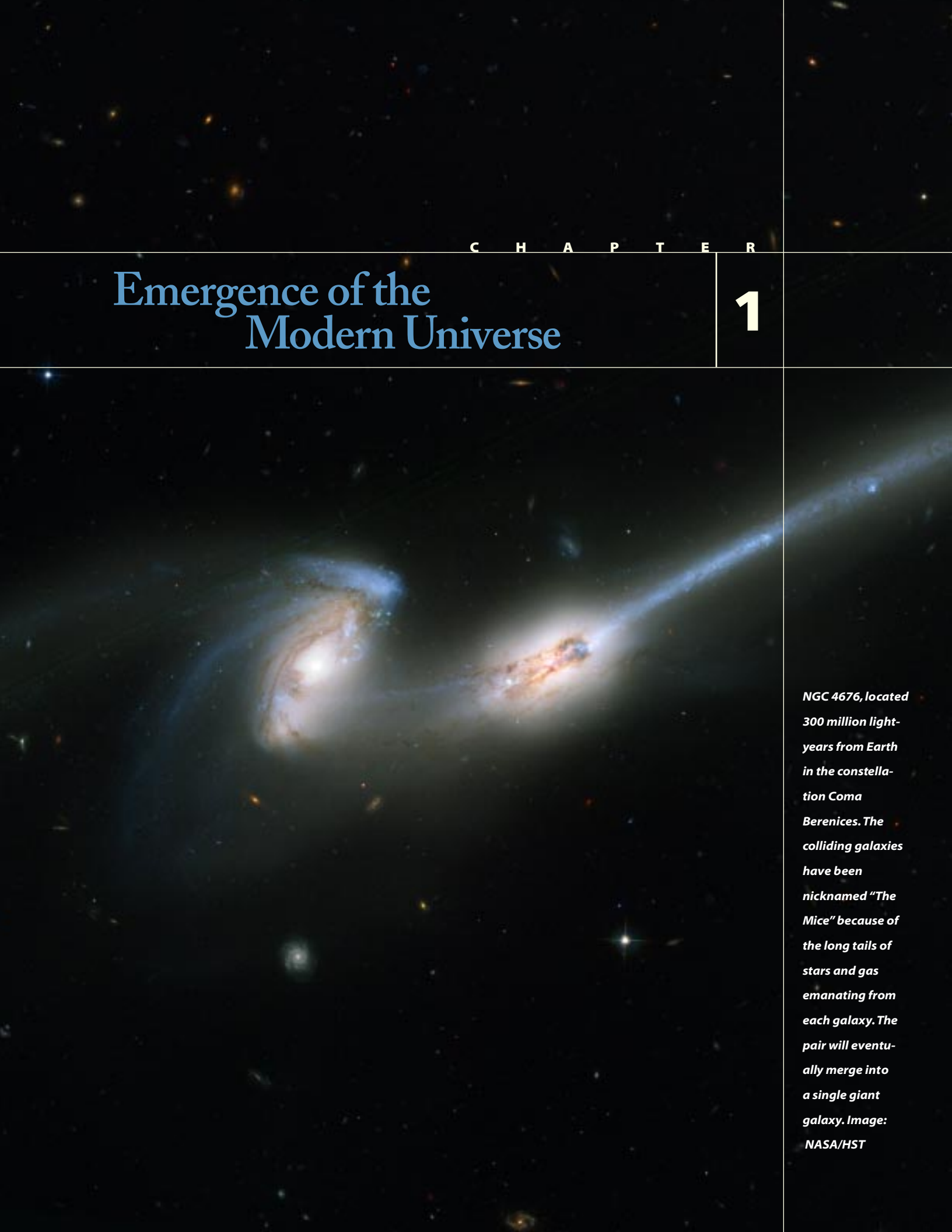
It is a key element of philosophy in the Origins theme that each major mission build upon the scientific and technical legacy of past missions, and develop new capabilities for those to follow. So, technology must be prepared and scientific theory and context must be developed to enable these missions to be defined and developed with an acceptable cost and risk. The Roadmap discusses those technology developments and research and analysis activities needed to prepare the scientific ground to conduct the investigations and to integrate and analyze the results to produce deep scientific understanding.

The two questions—“Where did we come from?” and “Are we alone?”—are simple and engaging enough to discuss with children in elementary school, yet are so profound as to challenge the scientific community and engage people in all walks of life. Therefore, the Roadmap describes a vigorous program of education and public outreach to engage all Americans and especially youth in the excitement and inspiration of this great quest.

Finally, the Roadmap concludes with a vision of the future, featuring possibilities for the kinds of investigations and missions that may be currently beyond our technological reach, but are not beyond our aspiration.

# Emergence of the Modern Universe

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*NGC 4676, located 300 million light-years from Earth in the constellation Coma Berenices. The colliding galaxies have been nicknamed "The Mice" because of the long tails of stars and gas emanating from each galaxy. The pair will eventually merge into a single giant galaxy. Image: NASA/HST*